SELECTRODIALYSIS PROCESS FOR HEAVY METAL SEPARATION AND RECOVERY FROM METALLURGICAL PROCESS STREAMS

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INTRODUCTION

There is an environmental challenge for the metallurgical and mining industries, especially for smelting, mining and processing of copper, due to the numerous environmental regulations imposed as well as the human health impact of heavy metal pollution. Copper metallurgical processes are generating complex residuals streams with high copper contents where it is accompanied by other base metals as zinc, nickel, cadmium and toxic non-metals as arsenic and bismuth, among others. Due to the economic value of such copper streams, several techniques such as chemical precipitation, adsorption or ion exchange are being proposed for its selective separation and concentration. In this study the use of ion selective membrane electrodialysis (IX-ED) has been evaluated to achieve a double objective: the separation and concentration of Cu(II) from streams containing mixtures of H_2SO_4/HNa_2AsO_4 by using an ion exchange membrane process with cation monovalent selective membranes, named ‘‘selectrodialysis (SED)”.

MATERIALS & METHODS

- Lab-scale SED stack (PCCell ED 64–004 with a cell of 11×11 cm)
- 3 cell triplets: monovalent selective cation exchange (MVC) membrane between the standard anion (MA) and cation exchange (MC) membranes (see **Figure 1**).
- Active membrane area: 64 cm^2

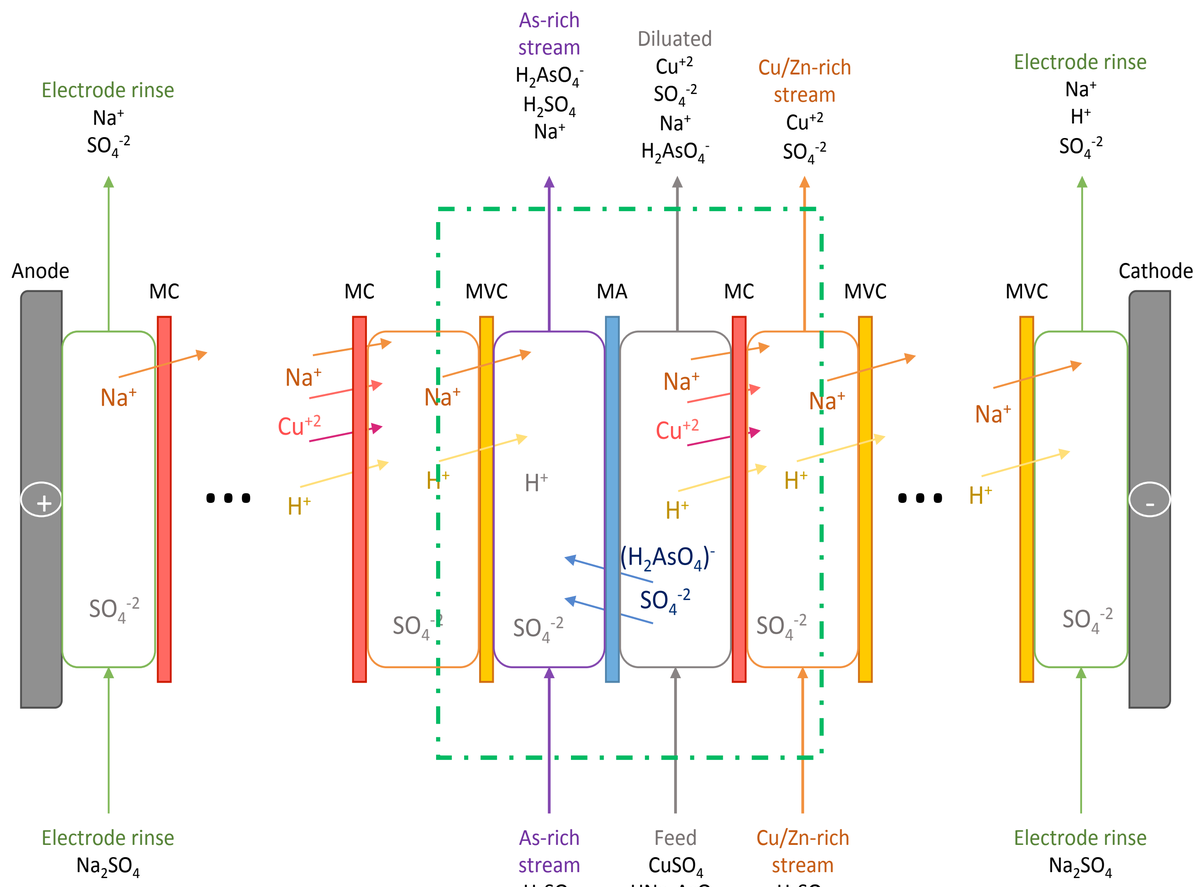

***Figure 1**. Scheme of SED configuration for the separation and recovery of Cu from As streams*

- Streams: electrode rinse, feed solution, Cu-rich product and As-rich product (see **Table 1**).
- Initial volume tanks: 1L
- Flow rates: 90-100 h/L for electrode rinse stream
  15-10 h/L for feed solution, Cu-rich product and As-rich product streams

***Table 1**. Operational conditions used in the SED process*

Feed solution (M)	$CuSO_4$	0.053
	HNa_2AsO_4	0.035
	pH	2.3
Cu-rich product (initial)		0.1 M H_2SO_4
As-rich product (initial)		0.1 M H_2SO_4
Electrode rinse (initial)		0.1 M Na_2SO_4
Membrane trios		3
Maximum current (A)		5
Maximum voltage (V)		7.5

RESULTS & DISCUSSION

Figure 2 and **Figure 3** show the concentration evolution of copper (Cu), arsenic (As), sulfate (SO_4) and sodium (Na) profiles in the electrode rinse stream, Cu-rich stream, feed stream and As-rich stream, respectively.

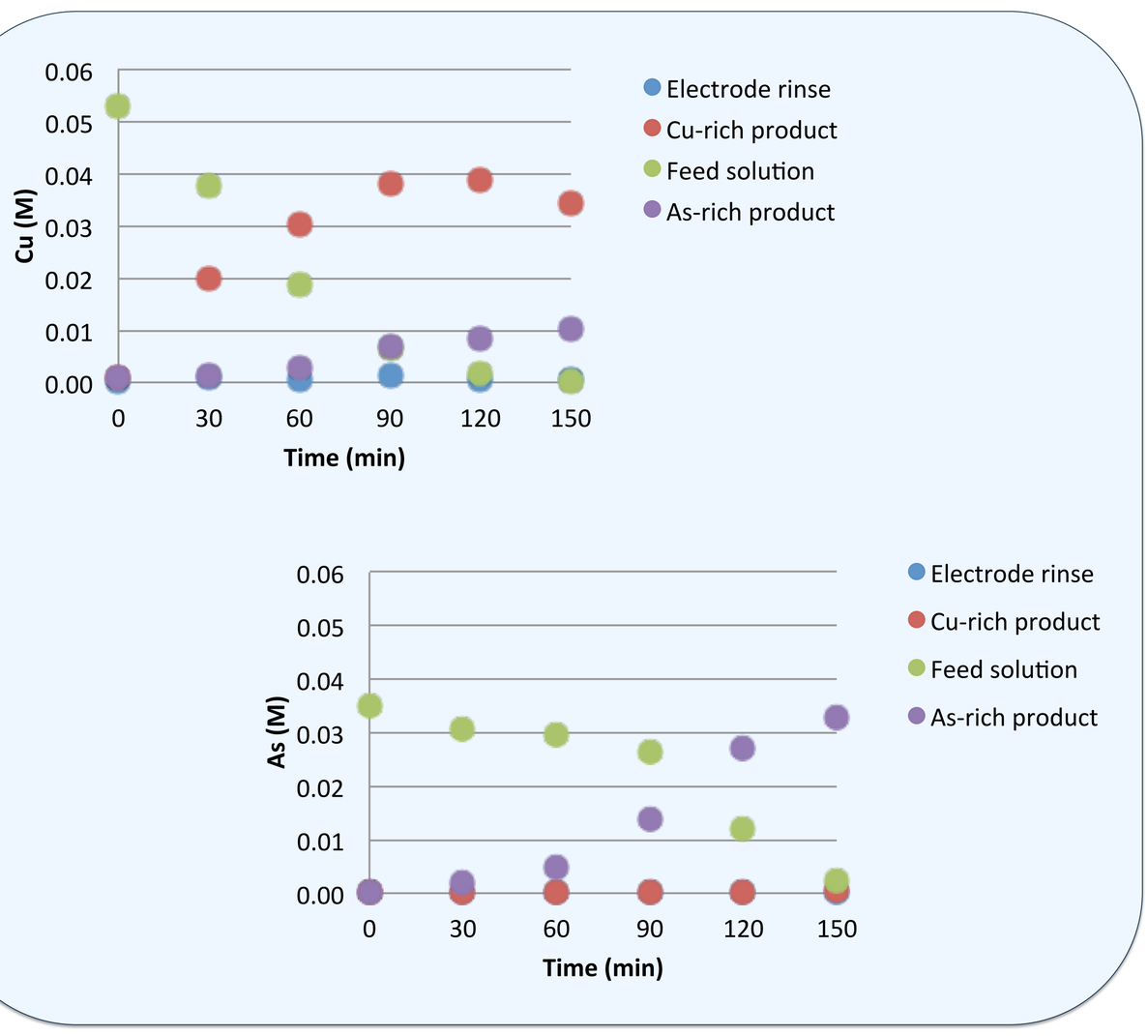

***Figure 2**. Evolution of the Cu and As concentration profiles in different streams*

The 74 % of the initial Cu was transferred from the feed solution to the Cu-rich stream by 120 min of operation, whereas only 16 % migrated to the As-rich stream. On the other hand, the 77 % initial As of the feed solution was transported through the MA to the As-rich solution after the same time of treatment (see **Figure 2**).

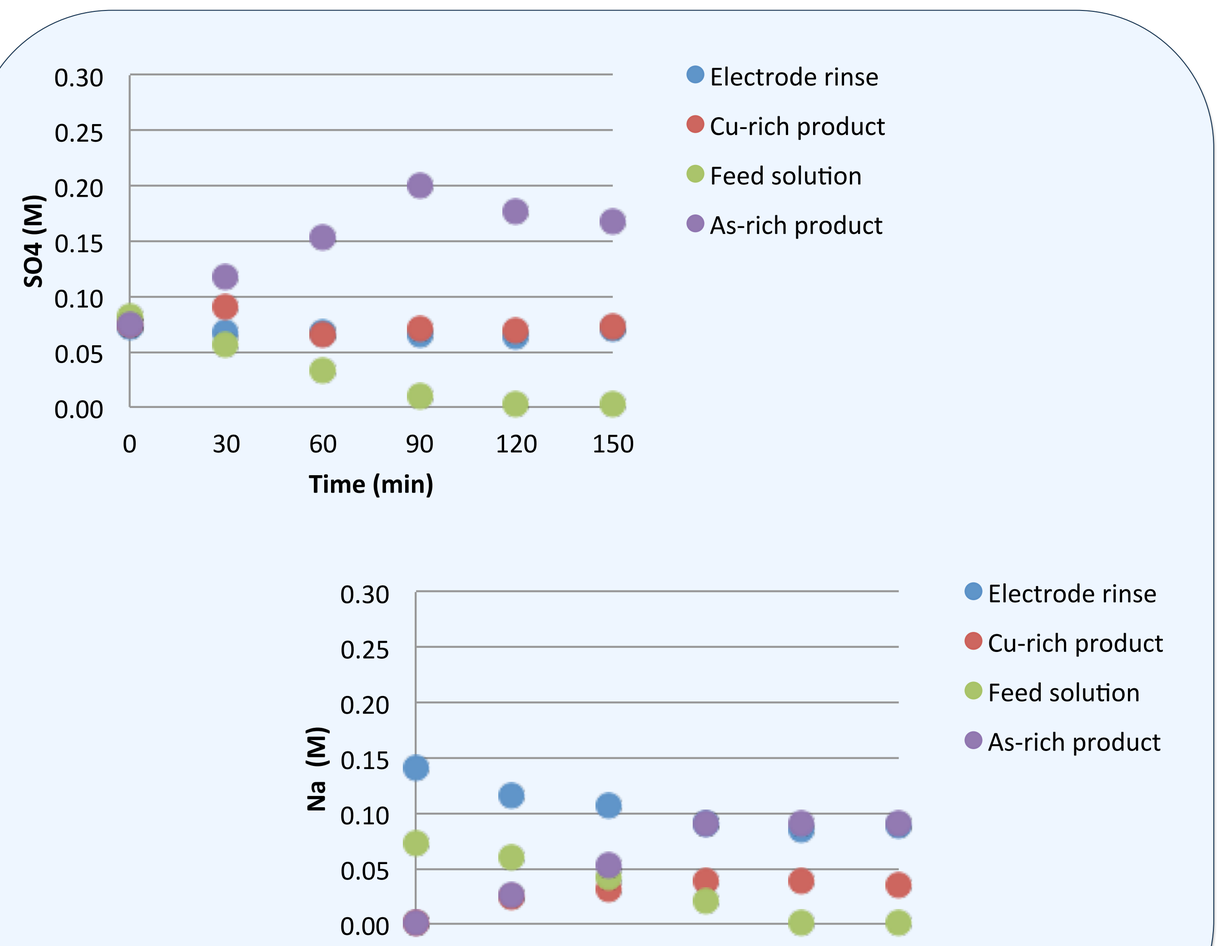

***Figure 3**. Evolution of the SO_4 and Na concentration profiles in different streams*

The SO_4 ions were transported during the first 90 min of operation from the feed compartment to the As-rich one, while after that time the sulfate ions concentration in this stream remained constant. On the other hand, the Na ions were transported from the feed to the As-rich and the Cu-rich streams (see **Figure 3**).

CONCLUSIONS

The results show that the feed stream was deconcentrated from around 97% for all ions presents in the effluent after 150 min of treatment. Furthermore, it was obtained a Cu-rich stream composed by 0.039 M of $CuSO_4$ and 0.008 M of HNa_2AsO_4, whereas a As-rich stream was reached, 0.033 M, free of copper impurities. Finally, results obtained suggest that SED is a sustainable alternative process as Cu recovery source.

ACKNOWLEDGEMENTS

This research received support from the Waste2Product project (CTM2014-57302-R) financed by the Spanish Ministry of Economy and Competitiveness (MINECO). As well, Mònica Reig and Xanel Vecino thank MINECO for their predoctoral (ref. BES-2012-051914) and postdoctoral grant (ref. FJCI-2014-19732), respectively. José Martínez (Universidad de Sevilla) is acknowledge for process metallurgy data.